SUSQUEHANNA RIVER BASIN
TRIBUTARY OF SNAKE CREEK, SUSQUEHANNA COUNTY

PENNSYLVANIA

BEL-AIR LAKE DAM

NDI I.D. PA-0066
DER I.D. 058-116
OWNER: BEL-AIR LAKE ASSOCIATION, INC.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DACW31-81-C-0014

PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
10 DUFF ROAD
PITTSBURGH, PA. 15235

AUGUST 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of a dam is based upon visual observations and review of available data. Detailed investigations and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation. However, the Phase I inspection is intended to identify any need for such studies which should be performed by the owner.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and the recommendations were made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Bel-Air Lake Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Susquehanna
STREAM: An unnamed tributary of Snake Creek, Susquehanna River Basin
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: High
OWNER: Bel-Air Lake Association, Inc.
DATE OF INSPECTION: March 24, 1981 and April 30, 1981

ASSESSMENT: Based on the evaluation of existing conditions, the condition of Bel-Air Lake Dam is considered to be unsafe/nonemergency due to a seriously inadequate spillway capacity.

The overall condition of the dam is considered to be fair. Although at this time no signs of significant distress were observed, it appears that the center of the dam has significantly settled. The design drawings show the design freeboard to be five feet, but the available freeboard is only approximately two feet. It also appears that fill has been placed on the downstream slope, increasing the crest width from the design value of 10 feet to about 30 feet near the center line of the dam and greater than 50 feet near the left abutment. The dam has no functional low level outlet facility.

The spillway capacity was evaluated according to the recommended criteria. According to this criteria, small dams in the high hazard category are required to pass from one-half to full Probable Maximum Flood (PMF). In view of the size of the dam which is closer to the lower limit of the small size classification, one-half of the PMF was selected as the spillway design flood. The present flood discharge capacity was then evaluated according to the recommended procedure and was found to pass less than 10 percent of the PMF without overtopping the embankment. Because the capacity is less than 50 percent of the PMF and results of a breach analysis indicate that the potential loss of life and downstream damage would be significantly increased due to a dam failure, the spillway is classified to be seriously inadequate.

The following recommendations should be implemented immediately:

1. The owner should immediately retain a professional engineer to conduct studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate capacity. Immediately, the crest of the dam should be filled to the design level under the supervision of a professional engineer and the upstream face should be provided with erosion protection.

2. The owner should investigate the operability of the outlet works and should perform any necessary maintenance required to make it functional or develop means to drain the lake in the event of an emergency, if required.

3. The deteriorating concrete associated with the spillway structures should be repaired.

4. Brush and trees on the downstream face of the dam should be removed.

5. A minor seepage area below the toe of the dam should be periodically inspected to determine if the seepage condition is worsening.

6. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of an emergency.

7. The owner should develop a formal operating and maintenance plan for the dam. Included in the plan should be a provision for regular inspection of the facility.

Assessment - Bel-Air Lake Dam

Lawrence D. Andersen, P.E.
Vice President

August 26, 1981
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

18 Sep 1981
Date

BEL-AIR LAKE DAM
NDI I.D. PA-0066
DER I.D. 058-116
MARCH 24, 1981

Dam Crest (looking north)

Dam Crest (looking south)

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NDI I.D. PA-0066
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SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. Bel-Air Lake Dam consists of an earth embankment approximately 250 feet long with a maximum height of approximately 17 feet from the downstream toe. The dam crest is irregular. The design crest width is shown to be 10 feet, but the width varies from 27 feet to greater than 50 feet. The narrowest crest section is located near the center of the dam. It appears that fill has been placed against the downstream embankment slope since the completion of the dam. The downstream embankment slope can be identified for only a 60- to 80-foot length of the dam near the original stream bed alignment. Over this length, the downstream slope is approximately 1 horizontal to 1 vertical and the face is covered with thick brush and trees. Over the remaining length of the dam, the embankment merges into the abutments such that the junctions of the abutments and the embankment are not easily identifiable.

The spillway of the dam consists of a concrete overflow spillway structure which is excavated into the right abutment. The spillway structure includes a 34-foot-wide, 5.5-foot-deep concrete overflow section which discharges onto a concrete apron, then into a grouted riprap chute, terminating at a plunge pool at the toe level of the dam. The low level outlet consists of a 12-inch-diameter corrugated metal pipe encased in concrete, extending from the upstream toe to the downstream toe near the center of the dam. Flow through this outlet pipe is controlled by a valve located at about the midpoint of the pipe. The valve is operated by a valve stem which extends to the embankment crest. The valve is reported to be inoperable.

b. Location. Bel-Air Lake Dam is located (N41° 57.0', W75° 52.2') on an unnamed creek, a tributary of Snake Creek, in the southwestern part of Liberty Township, Susquehanna County, Pennsylvania. Plate 1 illustrates the location of the dam.

c. Size Classification. Small (based on 17-foot height and 115 acre-feet maximum storage capacity).

d. Hazard Classification. The dam is classified in the high hazard category. Downstream from the dam, the unnamed creek flows under State Route 29 at approximately 1.5 miles from the dam and then joins Snake Creek near the Village of Lawsville. A house, a general store, a gas station, and a church, all located within the Village of Lawsville, constitute the main impact area of the flood which might be associated with a dam failure. The basement levels of the buildings are estimated to be within 5 to 10 feet of the stream bed. It is estimated that State Route 29 would also be damaged if the dam failed. Failure of the dam would probably cause loss of more than a few lives and appreciable property damage in this area.

e. Ownership. Bel-Air Lake Association, Inc. (Address: Mr. Paul Labosky, Vice President, Bel-Air Lake Association, Inc., 1115 Richard Street, Johnson City, New York 13790.)

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was originally designed by McFarland and Brown Engineers of Binghamton, New York, in 1947. However, prior to completion of the original structure, the dam design was revised in 1949 by Mr. Regis C. McNamare (Licensed Professional Engineer, State of New York) to incorporate a 2.5-foot increase in the height of the embankment and in the crest level of the spillway. The dam was constructed by Mr. Stanley Yenkinevitch of Dimock, Pennsylvania, with completion in 1950.

h. Normal Operating Procedure. The reservoir is normally maintained at the spillway crest level, leaving 1.8 feet of freeboard below the measured low spot of the dam. Excess inflows into the reservoir are discharged over the spillway structure.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were determined based on field measurements, assuming the spillway crest to be at Elevation 1410 (USGS Datum) as interpolated from the USGS 7.5-minute Franklin Forks quadrangle. Design elevations are relative to arbitrary site data.

a. Drainage Area 1.49 square miles(1)

(1) Planimetered from USGS topographic map. State records indicate the drainage area to be 1.12 or 1.18 square miles.

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	Unknown(2)
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	271
Total spillway capacity at maximum pool	271

c. Elevation (USGS Datum) (feet)

Top of dam	1411.8 (existing low spot) 1415.0 (design)
Maximum design pool	1415.0
Normal pool	1410.0
Upstream invert outlet works	1397 (design)
Downstream invert outlet works	1396.5 (design)
Maximum tailwater	Unknown
Toe of dam	1395±

d. Reservoir Length (feet)

Normal pool level	1600±
Maximum pool level	1800±

e. Storage (acre-feet)

Normal pool level	89 (design)
Maximum pool level	115

f. Reservoir Surface (acres)

Normal pool level	13.8
Maximum pool level (existing)	15.5

g. Dam

Type	Earth embankment with concrete gravity spillway
Length	250 feet
Height	17 feet
Top width	Varies from 27 feet to greater than 50 feet
Side slopes	Downstream: Varies from 1H:1V to 6H:1V Upstream: 3H:1V (design)
Zoning	No
Impervious core	No
Cutoff	Yes
Grout curtain	No

(2) Outlet pipe is not operable.

h. Regulating Outlet

Type	12-inch-diameter corrugated metal pipe, reportedly encased in concrete
Length	97± feet (design)
Closure	12-inch-diameter valve
Access	Valve chamber and stem located on embankment crest
Regulating facilities	Valve

i. Spillway

Type	Concrete overflow weir structure with rectangular-shaped crest
Length	34 feet (perpendicular to flow)
Crest elevation	1410
Upstream channel	Lake
Downstream channel	Concrete chute and earth channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available data consist of files provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), which contain design drawings, correspondence and inspection reports.

(1) Hydrology and Hydraulics. Review of the information contained in the Commonwealth of Pennsylvania files revealed that there are no original hydrologic and/or hydraulic design data available for the dam.

(2) Embankment. The available information consists of design drawings.

(3) Appurtenant Structures. The available information consists of design drawings.

b. Design Features

(1) Embankment. As designed, the dam is a homogeneous earth embankment with a central cutoff trench extending for the full length of the embankment. Plate 2 shows the plan of the dam, and Plate 3 the valley profile and typical sections of the dam. The construction specifications required that all stone exceeding five inches in size should be removed from the fill materials. Material was to be placed in horizontal layers six inches in depth, and each layer thoroughly compacted. No internal drainage system was incorporated into the embankment design.

As shown on Plate 3, the embankment was designed to have a 2H:1V slope on the downstream face and a 3H:1V slope on the upstream face.

(2) Appurtenant Structures. The appurtenant structures consist of a concrete overflow spillway located at the right abutment and a low level outlet located near the center of the embankment. Details of the spillway structure are shown in Plate 4. The spillway structure consists of a 34-foot-wide concrete overflow section with concrete sidewalls. The overflow section is shown to be a gravity structure with a base width of 9 feet and a height of 10.5 feet. As designed, the spillway sidewalls terminated about 10 feet downstream from the overflow section. Presently, the sidewalls extend about 30 feet downstream from the overflow section and a concrete slab has been provided below the overflow section as a spillway apron. According to the owner's representative, a grouted riprap chute was constructed below the spillway apron in the early 1970's.

The low level outlet is a 12-inch-diameter corrugated metal pipe, reportedly encased in concrete. The upstream and downstream ends of the pipe are equipped with concrete headwalls. The pipe also is reported to have concrete cutoff collars along its length. Flow through the pipe is controlled by a valve located on the upstream side of the embankment. The valve is operated by a valve stem which extends to the dam crest level. Details of the outlet works are shown on Plate 3.

c. Design Data

(1) Hydrology and Hydraulics. A Commonwealth of Pennsylvania report entitled "Report Upon the Application of Howard H. Walker," dated November 5, 1947, indicates that the spillway was sized to pass a discharge of 1326 cfs.

(2) Embankment. No engineering data are available on the design of the embankment.

(3) Appurtenant Structures. No engineering data are available on the appurtenant structures.

2.2 Construction. Available information indicates that the dam was constructed by Mr. Stanley Yenkinevitch, a local contractor from Dimock, Pennsylvania. It appears that prior to completion of the original dam construction, additional construction was undertaken in 1949 to raise the dam by 2.5 feet. Fill was placed on the upstream and downstream embankment slopes and the spillway structure was modified. Visual observations indicate that subsequent to the 1949 modifications, additional fill has been placed on the downstream slope of the dam. The modifications to the spillway structure are discussed in Section 2.1 b (2).

2.3 Operation. There are no formal operating records maintained for the dam.

2.4 Other Investigations. The available information indicates that no additional investigations have been performed other than the periodic inspections conducted by the state. The last state inspection was conducted in 1977.

2.5 Evaluation

a. Availability. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources.

b. Adequacy

(1) Hydrology and Hydraulics. The available information is limited. Only the watershed area and design discharge capacity of the spillway are reported.

(2) Embankment. The design approach, construction techniques, and design documents lack such considerations as embankment slope stability and seepage analyses. However, the design does incorporate such basic components as an impervious cutoff trench and erosion protection of the spillway discharge channel.

(3) Appurtenant Structures. Review of the design drawings indicates that, as designed, no significant deficiencies exist that should affect the overall performance of these facilities.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The onsite inspection of Bel-Air Lake Dam consisted of:

1. The visual inspection of the embankment, abutments, and embankment toe.

2. The visual examination of the spillway and its components and the downstream end of the outlet pipe.

3. The evaluation of the downstream area hazard potential.

The specific observations are illustrated on Plate 5.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing the general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the embankment is considered to be fair. The most significant condition noted was that the center of the dam was significantly lower than the top of the spillway sidewalls, significantly reducing the potential discharge capacity of the spillway. By field survey, the available freeboard measured relative to the low section on the crest of the dam was only about 1.8 feet. Plate 6 shows the existing dam crest profile. The design drawings indicate that the design freeboard was five feet. Therefore, the center of the dam appears to have settled. At this time, no other indications of ongoing settlement were noted. The middle portion of the downstream face is covered with trees and brush.

Aside from a minor seepage area (5 to 10 gallons per minute) located in the original stream channel about 30 to 40 feet downstream from the toe of the dam, no other indications of distress were noted.

c. Appurtenant Structures. The appurtenant structures were examined for deterioration or other indications of distress and for obstructions that might limit flow capacity. In general, the structures were found to be in fair condition. The concrete surfaces of the spillway sidewalls were found to be deteriorating at sections. The low level outlet was reported to be nonfunctional.

d. Reservoir Area. A map review indicates that the watershed is predominantly woodlands and pasturelands. A review of the regional geology (Appendix F) indicates that the slopes of the reservoir are not likely to be susceptible to landslides which would significantly decrease the storage volume of the reservoir.

e. Downstream Channel. Flow from the spillway appears to be eroding the abutment side of the spillway discharge channel. The spillway structures are not affected by the erosion area at the present time. Further description of the downstream conditions is included in Section 1.2 d.

3.2 Evaluation. The most significant condition noted was that the center portion of the embankment is significantly lower than the design dam crest level, thus reducing the potential discharge capacity of the spillway. Other conditions noted were that the low level outlet was reported to be nonfunctional and in need of repair and that the downstream embankment slope is covered with brush and small trees which should be cleared. The upstream face requires erosion protection.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the spillway crest level with excess inflows discharged through the spillway structure.

4.2 Maintenance of the Dam. The maintenance condition of the dam is considered to be fair. Although the dam crest appears to be mowed periodically, the downstream slope is covered with brush and small trees which should be cleared.

4.3 Maintenance of Operating Facilities. The only operating facility of the dam is the valve of the outlet pipe. The owner reported that the outlet pipe valve is nonfunctional.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available via residences in the vicinity of the dam.

4.5 Evaluation. The maintenance condition of the dam is considered to be fair. However, the operating facility is in poor condition. It is recommended that necessary repairs be undertaken to make the low level outlet functional or that other methods be developed for draining the lake during emergencies. It is considered advisable to clear the brush and trees from the downstream embankment slope and to repair the deteriorating concrete of the spillway structure.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Bel-Air Lake Dam drains a watershed area of 1.5 square miles and impounds a reservoir with a surface area of 13.8 acres at its normal pool level. Flood discharge facilities for the dam consist of a concrete overflow spillway structure which has a rectangular shaped weir crest for control. Based on the available freeboard relative to the low spot of the dam, the capacity of the spillway is estimated to be 271 cfs.

b. Experience Data. As previously stated, Bel-Air Lake Dam is classified as a small dam in the high hazard category. According to the recommended criteria for evaluating spillway discharge capacities, such impoundments are required to accommodate floods between one-half and full PMF. In view of the height of the dam and the reservoir storage volume which are both near the lower limit of the small size category, one-half of the PMF was selected as the spillway design flood.

The PMF inflow hydrograph for the reservoir was determined utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. As determined by the computer program, the one-half PMF inflow hydrograph has a peak value of 2040 cfs. The computer input and a summary of the computer output are also included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed which indicate that the spillway capacity would be significantly reduced during the passage of a flood.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir. It was found that the dam can accommodate less than 10 percent of the PMF without overtopping the dam. For 50 percent of the PMF, it was found that the low area of the embankment would be overtopped for a duration of 8.5 hours and by a maximum depth of 2.1 feet.

e. Spillway Adequacy. Since the spillway cannot pass the recommended spillway design flood of one-half PMF without overtopping the dam, the spillway is classified to be inadequate.

A breach analysis was conducted to analyze whether failure resulting from overtopping would significantly increase the potential for loss of life or damage above that which would be expected during the same flood, but without failure. In the breach analysis, a trapezoidal breach

section was assumed with a 50-foot bottom width, 1H:1V sideslopes, and a 17-foot maximum breach depth. The duration of failure was assumed to be 0.75 hour, with breaching initiated when the dam was overtopped at least by 1 foot. It was found that the dam would be overtopped in excess of 1 foot during the passage of 30 percent of the PMF. The computer outputs for the breach analysis are included in Appendix D.

Review of the computed Village of Lawsville flood stages resulting from failure of Bel-Air Lake Dam indicates that while the discharge from the dam assuming no failure (1202 cfs, 30 percent PMF) would be essentially contained within the banks of the stream, the discharge due to dam failure would increase to about 4440 cfs, overtopping the stream banks by about 3 feet. This possible increase in discharge will likely cause a significant increase in the potential for loss of life and downstream damage. Therefore, the existing flood discharge capacity of Bel-Air Lake Dam is considered to be seriously inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, although the embankment appears to have settled, no signs of distress were noted that would significantly affect the stability of the dam at this time.

(2) Appurtenant Structures. Although some deterioration of concrete was observed along the spillway structure, the overall structural condition is considered to be satisfactory. No portions of the low level outlet facilities were visible. Thus, their structural conditions could not be assessed.

b. Design and Construction Data

(1) Embankment. The available design and construction information does not provide any quantitative data which could aid in the assessment of the embankment stability. However, as previously noted, field observations did not reveal any signs of distress that would significantly affect the stability of the embankment at this time and none were reported in the past. Therefore, based on visual observations, the static stability of the embankment is considered to be adequate.

(2) Appurtenant Structures. Other than design drawings, no design and/or construction data exists relative to the appurtenant structures. Review of the drawings indicates that there are no apparent structural deficiencies that would significantly affect the performance of the appurtenant structures.

c. Operating Records. None available.

d. Postconstruction Changes. As noted, it appears that a large amount of fill has been placed on the downstream slope of the dam since completion of construction. Modifications to the spillway structures are discussed in Section 2.1 b (2).

e. Seismic Stability. The dam is located in Seismic Zone 1; and based on visual observations, the static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for the evaluation of seismic stability of dams, the structure is presumed to present no hazard as a result of earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. In view of the seriously inadequate spillway capacity, the condition of Bel-Air Lake Dam is considered to be unsafe/nonemergency. The condition of the embankment is considered to be fair. Although the dam crest appears to have settled, no indications of distress were noted that would raise concern about the stability of the dam under normal pool conditions.

The spillway was evaluated according to the recommended procedure and was found to pass less than 10 percent of the PMF without overtopping the dam. According to the recommended criteria, small dams in the high hazard category are required to pass one-half to full PMF. In view of the height of the dam which is closer to the lower limit of the small size classification, one-half PMF was selected as the spillway design flood. The available spillway capacity is less than the spillway design flood of one-half PMF. Results of a breach analysis indicate that the potential for loss of life and downstream damage would be significantly increased if the dam should fail. Therefore, the spillway is classified as being seriously inadequate.

b. Adequacy of Information. The available information, in conjunction with visual observations, is considered to be sufficient to make a Phase I evaluation.

c. Urgency. The following recommendations should be implemented immediately.

d. Necessity for Additional Investigations. In view of the seriously inadequate spillway capacity, the owner should promptly retain the services of a professional engineer to determine the nature and extent of improvements required to provide an adequate spillway. In the interim, the crest of the dam should be filled to the design level under the supervision of a professional engineer and means should be developed to drain the lake during emergencies.

7.2 Recommendations/Remedial Measures.

It is recommended that:

1. The owner should immediately retain a professional engineer to conduct studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate capacity. Immediately, the crest of the dam should be filled to the design level under the supervision of a professional engineer and the upstream face should be provided with erosion protection.

2. The owner should investigate the operability of the outlet works and should perform any necessary maintenance required to make it functional or develop means to drain the lake in the event of an emergency, if required.

3. The deteriorating concrete associated with the spillway structures should be repaired.

4. Brush and trees on the downstream face of the dam should be removed.

5. A minor seepage area below the toe of the dam should be periodically inspected to determine if the seepage condition is worsening.

6. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of an emergency.

7. The owner should develop a formal operating and maintenance plan for the dam. Included in the plan should be a provision for regular inspection of the facility.

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Bel-Air Lake Dam COUNTY Susquehanna STATE Pennsylvania ID# NDI: PA-0066
DER: 058-116

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION March 24, 1981 WEATHER Sunny TEMPERATURE 42

POOL ELEVATION AT TIME OF INSPECTION 1410± M.S.L. TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL:	REVIEW INSPECTION PERSONNEL: (April 30, 1981)
Bilgin Erel, P.E.	Lawrence D. Andersen, P.E.
Wah-Tak Chan, P.E.	James H. Poellot, P.E.
Arthur Smith	Bilgin Erel, P.E.

Bilgin Erel, P.E. RECORDER

Owner's Representatives:
Mr. Paul Lobosky, V.P.
Mr. Bernard Gerrer, Sec. Treas.
Mr. Meerri McClure

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment is irregular. See Plate 6 for dam crest profile. Crest width is variable.	The dam crest should be filled at least to design level.
RIPRAP FAILURES	Upstream slope of embankment has no riprap protection.	Owner should provide erosion protection along the upstream slope of the dam.

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problems observed.	
ANY NOTICEABLE SEEPAGE	A wet area near the toe in the vicinity of the low level outlet (seepage in the amount of 5 to 10 gallons per minute).	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet pipe not visible (12-inch-diameter corrugated metal pipe, reportedly encased in concrete).	
INTAKE STRUCTURE	Submerged, not visible.	
OUTLET STRUCTURE	Not visible.	
OUTLET CHANNEL	Unprotected earth channel.	
EMERGENCY GATE	Valve reported to be nonfunctional by the owner.	Outlet facilities should be repaired or plans should be developed to drain the lake during emergencies.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Some surficial concrete deterioration.	
APPROACH CHANNEL	Lake	
DISCHARGE CHANNEL	Spillway apron and chute are in fair condition. Right side of the discharge channel below the spillway chute is eroding.	Erosion problem below the spillway chute should be periodically observed to determine if conditions are worsening and remedial measures should be undertaken.
BRIDGE AND PIERS	None	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	The dam has no gated spillway.	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	No problems observed.	
SEDIMENTATION	Unknown	
UPSTREAM RESERVOIRS	None	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No problems observed.	
SLOPES	No problems observed.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Village of Lawsville is located about 1.5 miles downstream from the dam. One house, a general store, a gas station, and a church are in the potential floodplain at this location. Population: 10 to 20.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC/HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Bel-Air Lake Dam
ID# NDI: PA-0066
DER: 058-116

ITEM	REMARKS
AS-BUILT DRAWINGS	The design drawings are available in state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was originally designed by McFarland and Brown Engineers, Binghamton, New York, in 1947; the design was modified by Mr. Regis McNamara (P.E., New York); and the dam was constructed by Stanley Yenkinevitch, Dimock, Pennsylvania, with completion in 1950.
TYPICAL SECTIONS OF DAM	See Plate 3.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 2 and 3.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None available.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available or reported.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None available.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	Unknown
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	The dam was raised by 2.5 feet in 1949 prior to the completion of the original construction. It appears that additional fill has been placed on the downstream embankment slope since 1950.
HIGH POOL RECORDS	None recorded.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	No maintenance records.
SPILLWAY PLAN SECTIONS DETAILS	See Plate 4.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plate 3.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 1.5 square miles, predominantly woodlands and pasturelands

ELEVATION, TOP OF NORMAL POOL AND STORAGE CAPACITY: 1410 (89 acre-feet)

ELEVATION, TOP OF FLOOD CONTROL POOL AND STORAGE CAPACITY: 1411.8 (115 acre-feet)

ELEVATION, MAXIMUM DESIGN POOL: 1415

ELEVATION, TOP OF DAM: 1411.8 (existing low spot)

SPILLWAY:

a. Elevation 1410±

b. Type Concrete overflow weir structure with concrete discharge apron and grouted riprap chute channel

c. Width 34 feet

d. Length 30± feet

e. Location Spillover Right abutment

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 12-inch corrugated metal pipe, reportedly encased in concrete

b. Location Along the stream bed near the center line of the dam

c. Entrance Inverts 1397 (design)

d. Exit Inverts 1396.5 (design)

e. Emergency Drawdown Facilities 12-inch-diameter valve (nonoperational)

HYDROMETEOROLOGICAL GAGES:

a. Type No gages

b. Location N/A

c. Records None

MAXIMUM NONDAMAGING DISCHARGE: 270 cfs (available spillway capacity)

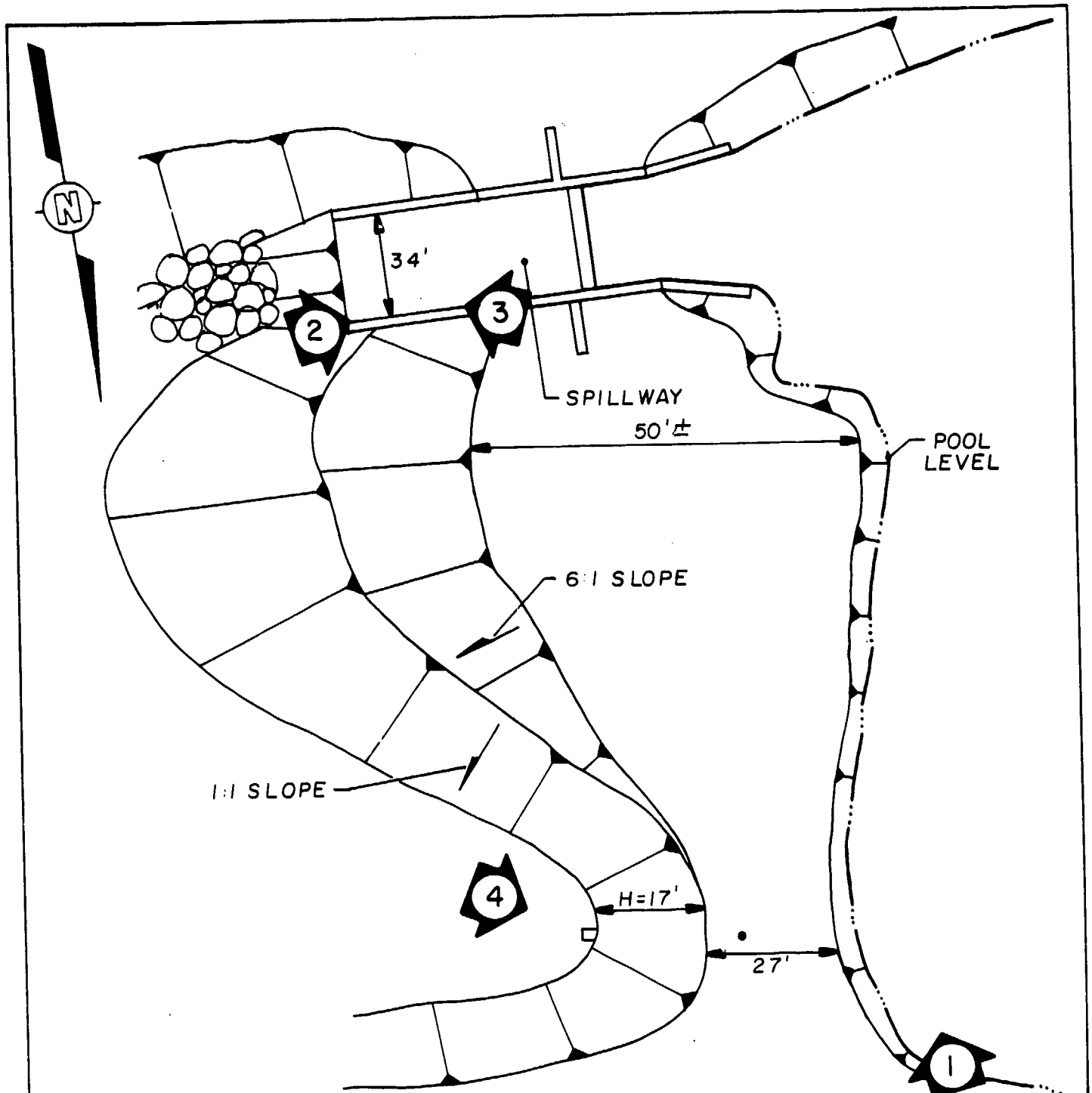
Note: Elevation Datum, USGS.

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
BEL-AIR LAKE DAM
NDI I.D. NO. PA-0066
MARCH 24, 1981

PHOTOGRAPH NO.	DESCRIPTION
1	Dam crest and upstream slope (lcoking south).
2	Spillway crest and approach channel.
3	Spillway discharge channel (note channel erosion below the plunge pool).
4	Seepage area near the toe of the dam.
5	Houses near Route 29 (approximately 1.5 miles downstream from the dam).
6	One store and two houses in the Village of Lawsville (approximately 1.5 miles downstream from the dam).



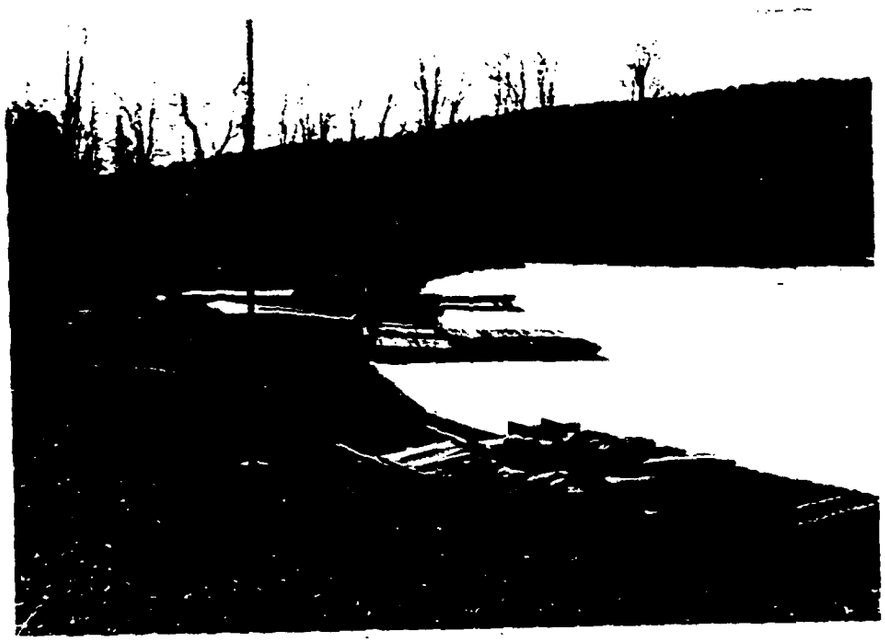
LEGEND :

2 INDICATES DIRECTION IN WHICH PHOTOGRAPH WAS TAKEN

BEL-AIR LAKE DAM
KEY PLAN OF PHOTOGRAPHS
FIELD INSPECTION DATE: MAR. 24, 1981

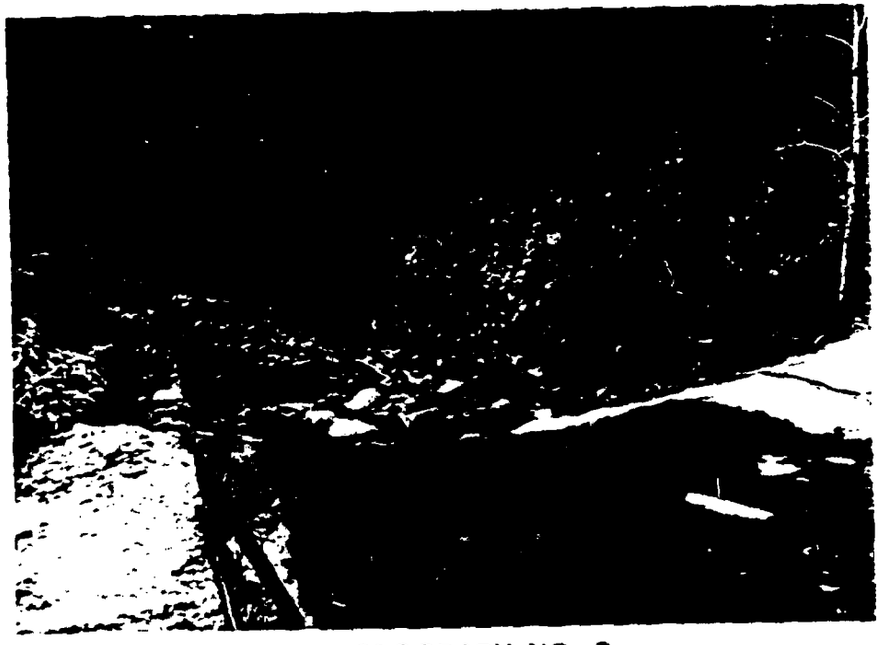
DAPPOLONIA

NOT TO SCALE



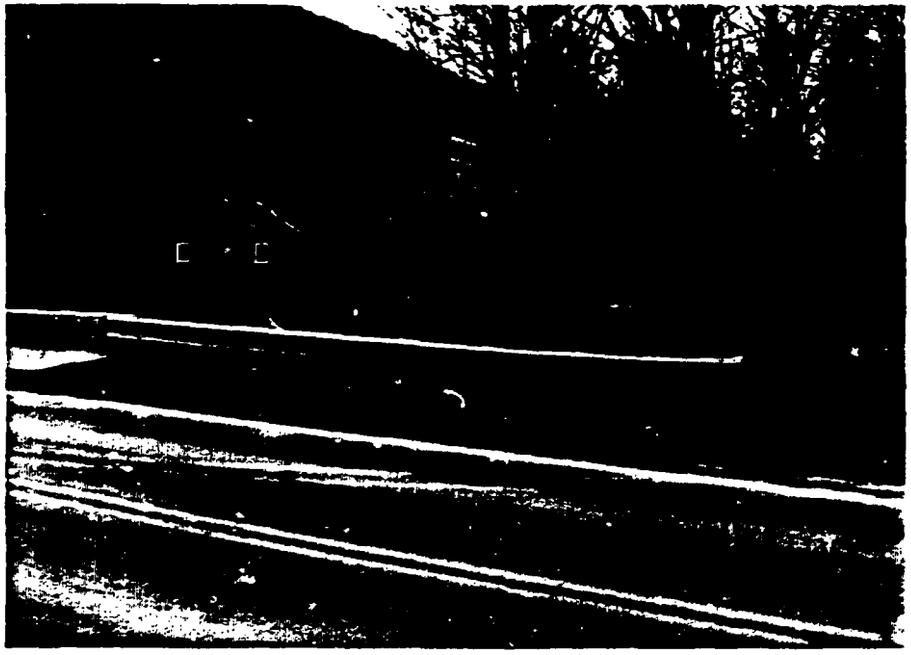
PHOTOGRAPH NO. 1

PHOTOGRAPH NO. 2

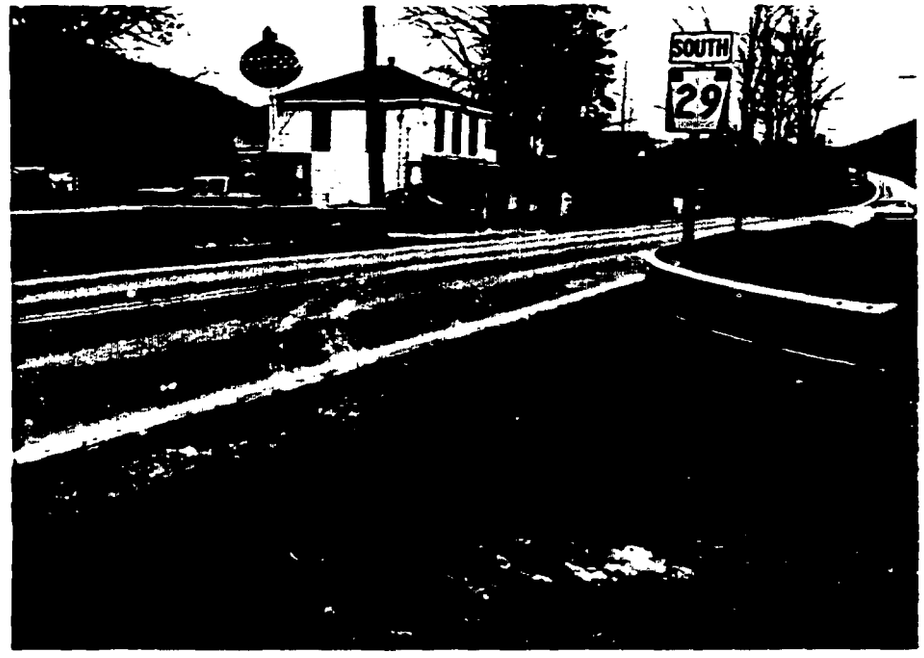


PHOTOGRAPH NO. 3

PHOTOGRAPH NO. 4



PHOTOGRAPH NO. 5



PHOTOGRAPH NO. 6

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Bel Air Lake Dam

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 INCHES/24 HOURS

STATION	1	2	3	4	5
Station Description	Bel Air Lake	Bel Air Lake Dam			
Drainage Area (square miles)	1.49	-			
Cumulative Drainage Area (square miles)	1.49	1.49			
Adjustment of PMP for Drainage Area (%)(1)	94%				
6 Hours	117	-			
12 Hours	127	-			
24 Hours	136	-			
48 Hours	142	-			
72 Hours	145	-			
Snyder Hydrograph Parameters					
Zone(2)	11A	-			
C_p/C_t(3)	0.62/1.5	-			
L (miles)(4)	1.89	-			
L_{ca} (miles)(4)	0.72	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.65	-			
Spillway Data					
Crest Length (ft)	-	34			
Freeboard (ft)	-	1.8			
Discharge Coefficient	-	3.3			
Exponent	-	1.5			

(1) Hydrometeorological Report 40, U.S. Weather Bureau and U.S. Department of the Army, 1965.
(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).
(3) Snyder's Coefficients.
(4) L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

STORAGE VS. ELEVATION

ELEVATION	ΔH, FEET	AREA (acres)(1)	ΔVOLUME (acre-feet)(2)	STORAGE (acre-feet)
1420		23.0		270.9
	10		182.1	
1410 (Normal pool elevation)		13.8		88.8
	15		88.8(3)	
1395 Reservoir Bottom		0.75(4)		0

(1) Planimetered from USGS maps.
(2) $\Delta Volume = \Delta H/3\ (A_1 + A_2 + \sqrt{A_1 A_2})$.
(3) From PennDER files.
(4) Back calculated from given reservoir surface area and volume values.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION   01 APR 80
**********
    1                 A1       SNYDER UNIT HYDROGRAPH, SPILLWAY, OVERTOPPING AND DAM BREACH ANALYSES
    2                 A2       BEL AIR DAM,(DER 58-116),SUSQUEHENNA COUNTY,PA.     PROJECT NO.80-556-20
    3                 A3       FOR 7%,20%,30%,50%,AND 100% PROBABLE MAXIMUM FLOOD(PMF)
    4                 B     300        0      15       0       0       0       0       0      -4       0
    5                 B1      5
    6                 J       2        5       1
    7                 J1   0.07     0.20    0.30    0.50    1.00
    8                 K       0        1                                                       1
    9                 K1       CALCULATION OF SNYDER INFLOW HYDROGRAPH TO BEL AIR DAM,(DER 58-116)
   10                 M       1        1    1.49            1.49                                       1
   11                 P                20.9     117     127     136     142     145
   12                 T                                                       1.0    0.05           0.0145
   13                 U    1.65     0.62
   14                 X    -1.5    -0.05     2.0
   15                 K       1        2                                                       1
   16                 K1       ROUTING FLOW THROUGH BEL AIR DAM,(DER 58-116)
   17                 Y                                        1       1
   18                 Y1      1                                                       -1410.0
   19                 SA   0.75     13.8     23.0
   20                 SE1395.0   1410.0   1420.0
   21                 SS1410.0     34.0      3.3     1.5
   22                 SD1411.8     2.65      1.5   230.0
   23                 SL   50.0    100.0    125.0   165.0   200.0   215.0   230.0
   24                 SV1411.8   1412.0   1412.1  1413.9  1415.5  1415.6  1416.1
   25                 SB   50.0      1.0   1395.0    0.75  1410.0  1420.0
   26                 SB   50.0      1.0   1395.0    0.75  1410.0  1412.8
   27                 K       1        3                                                       1
   28                 K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 1 (STATION 0+00 TO 8+00)
   29                 Y                                        1       1
   30                 Y1      1
   31                 Y6 0.045    0.045    0.045  1340.0  1349.5   800.0  0.0688
   32                 Y7   0.0   1400.0     50.0  1380.0   120.0  1360.0   190.0  1340.0   200.0  1340.0
   33                 Y7 220.0   1360.0    260.0  1380.0   300.0  1400.0
   34                 K       1        4                                                       1
   35                 K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 2 (STATION 8+00 TO 43+00)
   36                 Y                                        1       1
   37                 Y1      1
   38                 Y6 0.045    0.040    0.045  1200.0  1209.5  3500.0  0.0400
   39                 Y7   0.0   1260.0     50.0  1240.0   100.0  1220.0   150.0  1200.0   160.0  1200.0
   40                 Y7 200.0   1220.0    270.0  1240.0   340.0  1260.0
   41                 K       1        5                                                       1
   42                 K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 3 (STATION 43+00 TO 71+00)
   43                 Y                                        1       1
   44                 Y1      1
   45                 Y6 0.045    0.040    0.045  1080.0  1089.5  2800.0  0.0429
   46                 Y7   0.0   1140.0     40.0  1120.0    80.0  1100.0   120.0  1080.0   130.0  1080.0
   47                 Y7 210.0   1100.0    240.0  1120.0   300.0  1140.0
   48                 K       1        6                                                       1
   49                 K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 4 (STATION 71+00 TO 79+00)
   50                 Y                                        1       1
```

COMPUTER INPUT OVERTOPPING ANALYSIS

```
                                                                                1
K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 1 (STATION 0+00 TO 8+00)
Y                                                1       1
Y1     1
Y6 0.045    0.045    0.045  1340.0  1349.5   800.0  0.0088
Y7   0.0  1400.0     50.0  1380.0   120.0  1360.0   190.0  1340.0   200.0  1340.0
Y7 220.0  1300.0    200.0  1380.0   300.0  1400.0
K      1       4                                                 1
K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 2 (STATION 8+00 TO 43+00)
Y                                                1       1
Y1     1
Y6 0.045    0.040    0.045  1200.0  1209.5  3500.0  0.0400
Y7   0.0  1260.0     50.0  1240.0   100.0  1220.0   150.0  1200.0   160.0  1200.0
Y7 200.0  1220.0    270.0  1240.0   340.0  1260.0
K      1       5                                                 1
K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 3 (STATION 43+00 TO 71+00)
Y                                                1       1
Y1     1
Y6 0.045    0.040    0.045  1080.0  1089.5  2800.0  0.0429
Y7   0.0  1140.0     40.0  1120.0    80.0  1100.0   120.0  1080.0   130.0  1080.0
Y7 210.0  1100.0    240.0  1120.0   300.0  1140.0
K      1       6                                                 1
K1       CHANNEL ROUTING USING MODIFIED PULS: REACH 4 (STATION 71+00 TO 79+00)
Y                                                1       1
Y1     1
Y6 0.045    0.040    0.045  1070.0  1079.5   800.0  0.0125
Y7   0.0  1120.0    150.0  1100.0   250.0  1080.0   300.0  1070.0   310.0  1070.0
Y7 400.0  1080.0    750.0  1100.0   900.0  1120.0
K      9
```

COMPUTER INPUT OVERTOPPING ANALYSIS
(Continued)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .07	RATIO 2 .20	RATIO 3 .30	RATIO 4 .50	RATIO 5 1.00
HYDROGRAPH AT	1	1.49	1	286.	816.	1224.	2040.	4079.
	(	3.86)	(	8.09)(	23.10)(	34.65)(	57.76)(	115.51)(
			2	286.	816.	1224.	2040.	4079.
			(	8.09)(	23.10)(	34.65)(	57.76)(	115.51)(
ROUTED TO	2	1.49	1	248.	801.	1207.	2018.	4042.
	(	3.86)	(	7.01)(	22.67)(	34.19)(	57.16)(	114.46)(
			2	248.	801.	4300.	4507.	4842.
			(	7.01)(	22.67)(	121.77)(	127.62)(	137.12)(
ROUTED TO	3	1.49	1	247.	801.	1207.	2019.	4044.
	(	3.86)	(	7.01)(	22.67)(	34.19)(	57.17)(	114.52)(
			2	247.	801.	4351.	4549.	4877.
			(	7.01)(	22.67)(	123.22)(	128.81)(	138.11)(
ROUTED TO	4	1.49	1	247.	798.	1206.	2020.	4051.
	(	3.86)	(	7.00)(	22.60)(	34.16)(	57.21)(	114.71)(
			2	247.	798.	4465.	4625.	4930.
			(	7.00)(	22.60)(	126.44)(	130.97)(	139.60)(
ROUTED TO	5	1.49	1	248.	796.	1204.	2019.	4053.
	(	3.86)	(	7.01)(	22.54)(	34.10)(	57.18)(	114.76)(
			2	248.	796.	4466.	4598.	4891.
			(	7.01)(	22.54)(	126.45)(	130.21)(	138.51)(
ROUTED TO	6	1.49	1	247.	797.	1202.	2017.	4053.
	(	3.86)	(	7.00)(	22.56)(	34.03)(	57.11)(	114.77)(
			2	247.	797.	4440.	4557.	4845.
			(	7.00)(	22.56)(	125.73)(	129.04)(	137.20)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1410.00	1410.00	1411.80
STORAGE	89.	89.	115.
OUTFLOW	0.	0.	271.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.07	1411.70	0.00	113.	248.	0.00	42.00	0.00
.20	1412.72	.92	129.	801.	5.50	41.50	0.00
.30	1413.15	1.35	136.	1207.	6.75	41.50	0.00
.50	1413.86	2.06	148.	2018.	8.50	41.50	0.00
1.00	1415.16	3.36	171.	4042.	10.75	41.50	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1410.00	1410.00	1411.80
STORAGE	89.	89.	115.
OUTFLOW	0.	0.	271.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.07	1411.70	0.00	113.	248.	0.00	42.00	0.00
.20	1412.72	.92	129.	801.	5.50	41.50	0.00
.30	1412.86	1.06	132.	4821.	2.38	41.15	40.50
.50	1412.84	1.04	131.	4912.	2.13	40.16	39.50
1.00	1413.03	1.23	134.	5217.	1.66	38.91	38.25

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	247.	1341.7	42.00
.20	801.	1343.2	41.50
.30	1207.	1344.0	41.50
.50	2019.	1345.1	41.50
1.00	4044.	1347.1	41.50

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	247.	1341.7	42.00
.20	801.	1343.2	41.50
.30	4351.	1347.3	41.25
.50	4549.	1347.5	40.25
1.00	4877.	1347.7	39.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	247.	1201.9	42.25
.20	798.	1203.5	41.50
.30	1206.	1204.3	41.50
.50	2020.	1205.5	41.50
1.00	4051.	1207.6	41.50

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	247.	1201.9	42.25
.20	798.	1203.5	41.50
.30	4465.	1207.9	41.25
.50	4625.	1208.0	40.25
1.00	4930.	1208.3	39.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	248.	1081.8	42.25
.20	796.	1083.2	41.75
.30	1204.	1083.9	41.50
.50	2019.	1085.0	41.50
1.00	4053.	1086.9	41.50

PLAN 2 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	248.	1081.8	42.25
.20	796.	1083.2	41.75
.30	4466.	1087.2	41.25
.50	4598.	1087.3	40.25
1.00	4891.	1087.5	39.00

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	247.	1072.1	42.25
.20	797.	1073.5	41.75
.30	1202.	1074.2	41.50
.50	2017.	1075.2	41.50
1.00	4053.	1076.9	41.50

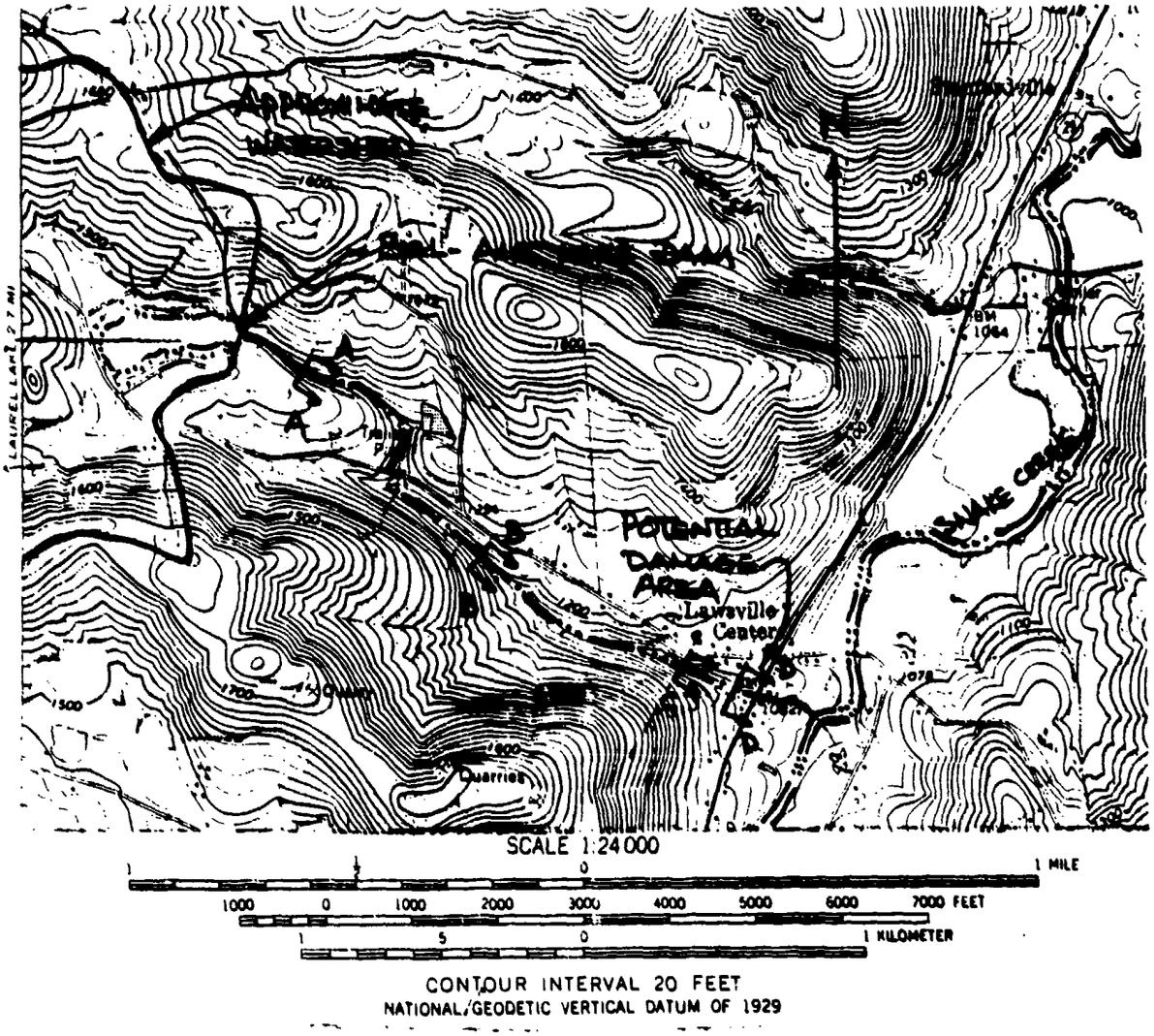
.20	797.	1073.5	41.75
.30	1202.	1074.2	41.50
.50	2017.	1075.2	41.50
1.00	4053.	1076.9	41.50

PLAN 2 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.07	247.	1072.1	42.25
.20	797.	1073.5	41.75
.30	4440.	1077.2	41.25
.50	4557.	1077.2	40.25
1.00	4845.	1077.4	39.00

D'APPOLONIA
CONSULTING ENGINEERS, INC

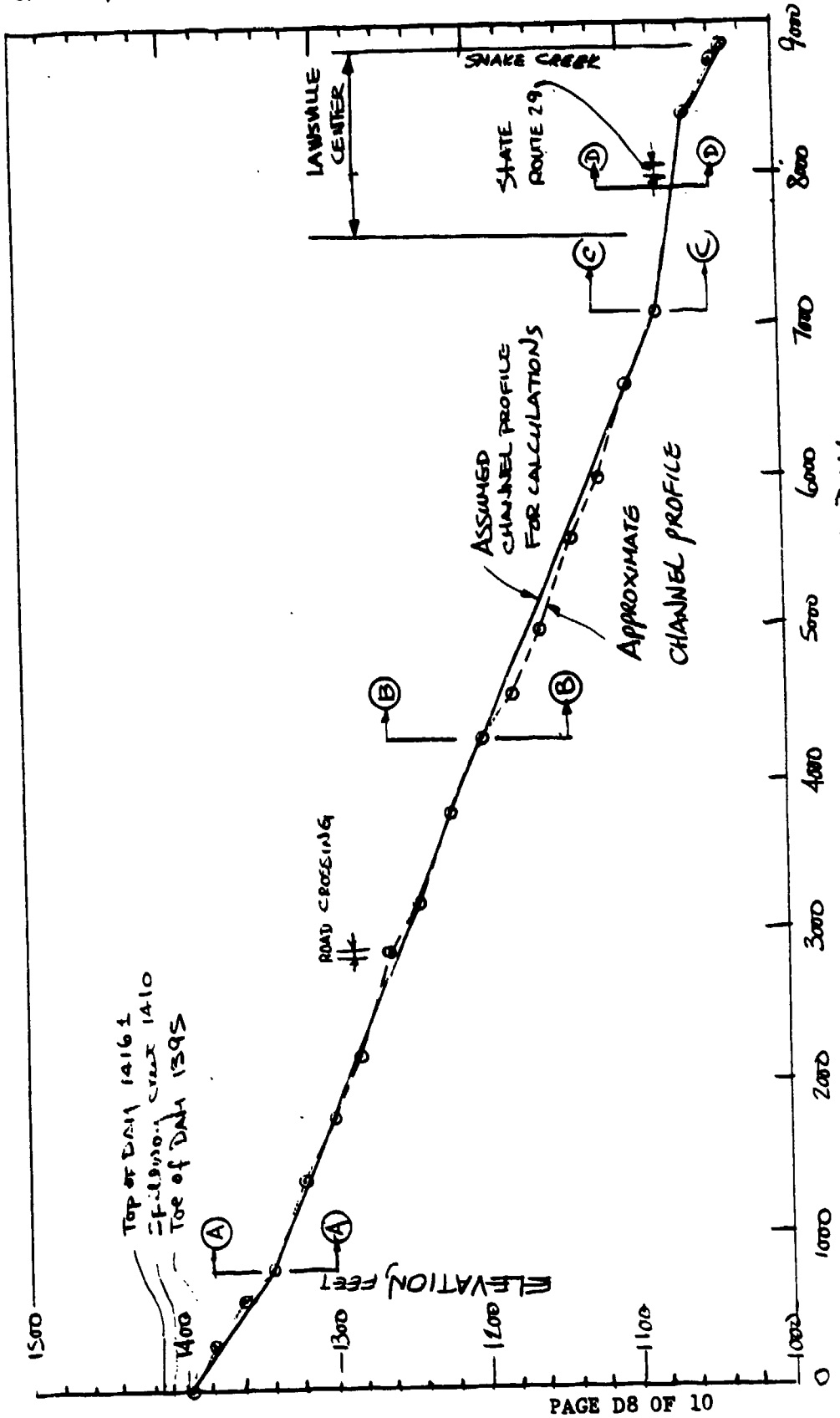
By WTC Date 7/28/81 Subject BEL-AIR LAKE DAM Sheet No. 1 of 4
Chkd. By MB Date 8/6/81 DOWNSTREAM CHANNEL PLAN Proj. No. 80-556



REFERENCE: 7.5 MINUTE U.S.G.S. TOPO MAP "FRANKLIN FORKS QUADRANGLE" PA-NY, PHOTOREVISED 1978

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WTC Date 7/28/81 Subject BEL-AIR LAKE DAM Sheet No. 2 of 4
Chkd. By [illegible] Date 8/6/81 Proj. No. 80-556



REFERENCE U.S.G.S. TOPOMAP "FRANKLIN FORKS QUADRANGLE", PA-NY, PHOTOREV 1978

D'APPOLONIA
CONSULTING ENGINEERS, INC.

By WTC Date 7/28/81 Subject BEL-AIR LAKE DAM Sheet No. 3 of 4
Chkd. By [illegible] Date 8/6/81 DOWNSTREAM CHANNEL SECTION Proj. No. 80-556

SECTION AA (Station 0+00 to 8+00)

* DISTANCE, FT	ELEVATION, FT	
0	1400	
50	1380	n=0.045
120	1360	
190	1340	n=0.045
200	1340	
220	1360	
260	1380	n=0.045
300	1400	

REACH LENGTH = 800 FT

$$\text{Slope} = \frac{1395 - 1340}{800} = 0.0688$$

NOTE: 10' wide streambed assumed for [illegible]

SECTION BB (STATION 8+00 TO 43+00)

* DISTANCE, FT	ELEVATION, FT	
0	1260	
50	1240	n=0.045
100	1220	
150	1200	n=0.040
160	1200	
200	1220	
270	1240	n=0.045
340	1260	

REACH LENGTH = 3500 FT

$$\text{slope} = \frac{1340 - 1200}{3500} = 0.0400$$

SECTION CC (STATION 43+00 to 71+00)

* DISTANCE, FT	ELEVATION, FT	
0	1140	
40	1120	n=0.045
80	1100	
120	1080	n=0.040
130	1080	
210	1100	
240	1120	n=0.045
300	1140	

REACH LENGTH = 2800 FT

$$\text{Slope} = \frac{1200 - 1080}{2800} = 0.0429$$

* DISTANCES ARE MEASURED FROM LEFT TO RIGHT, SECTIONS LOOKING DOWNSTREAM

SECTION DD (STATION 71+00 to 79+00)

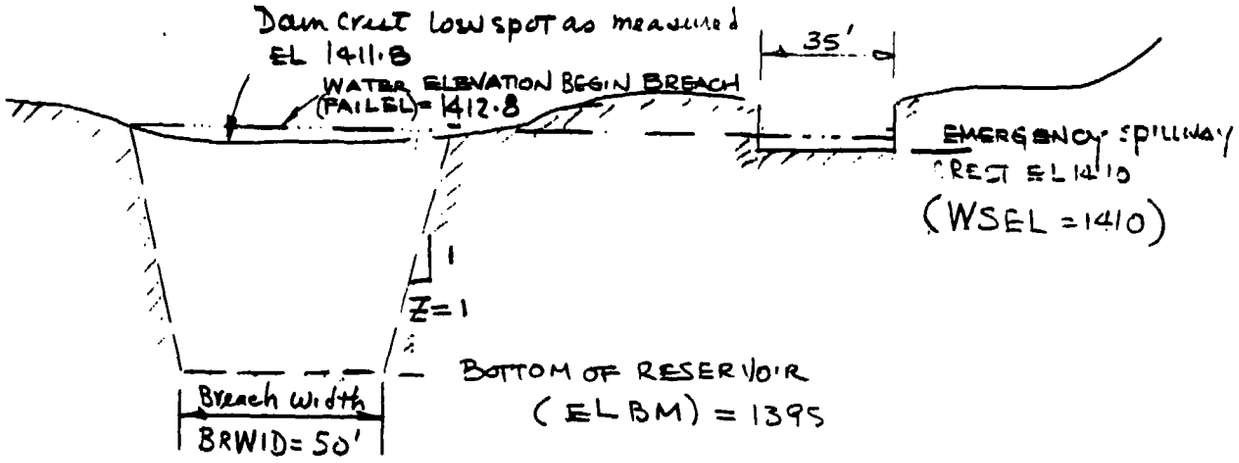
DISTANCE, FT	ELEVATION, FT	
0	1120	
150	1100	n=0.045
250	1080	
300	1070	n=0.040
310	1070	
400	1080	
750	1100	n=0.045
900	1120	

REACH LENGTH = 800 FT

$$\text{Slope} = \frac{1080 - 1070}{800} = 0.0125$$

DAM BREACH ASSUMPTIONS

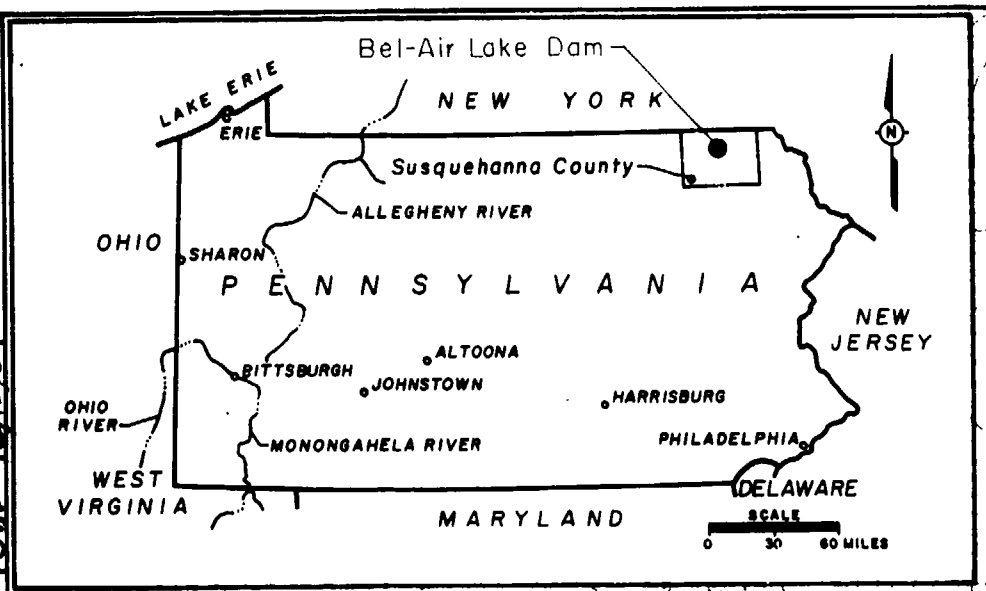
BREACH TIME (TFAIL) = 45 MINUTES



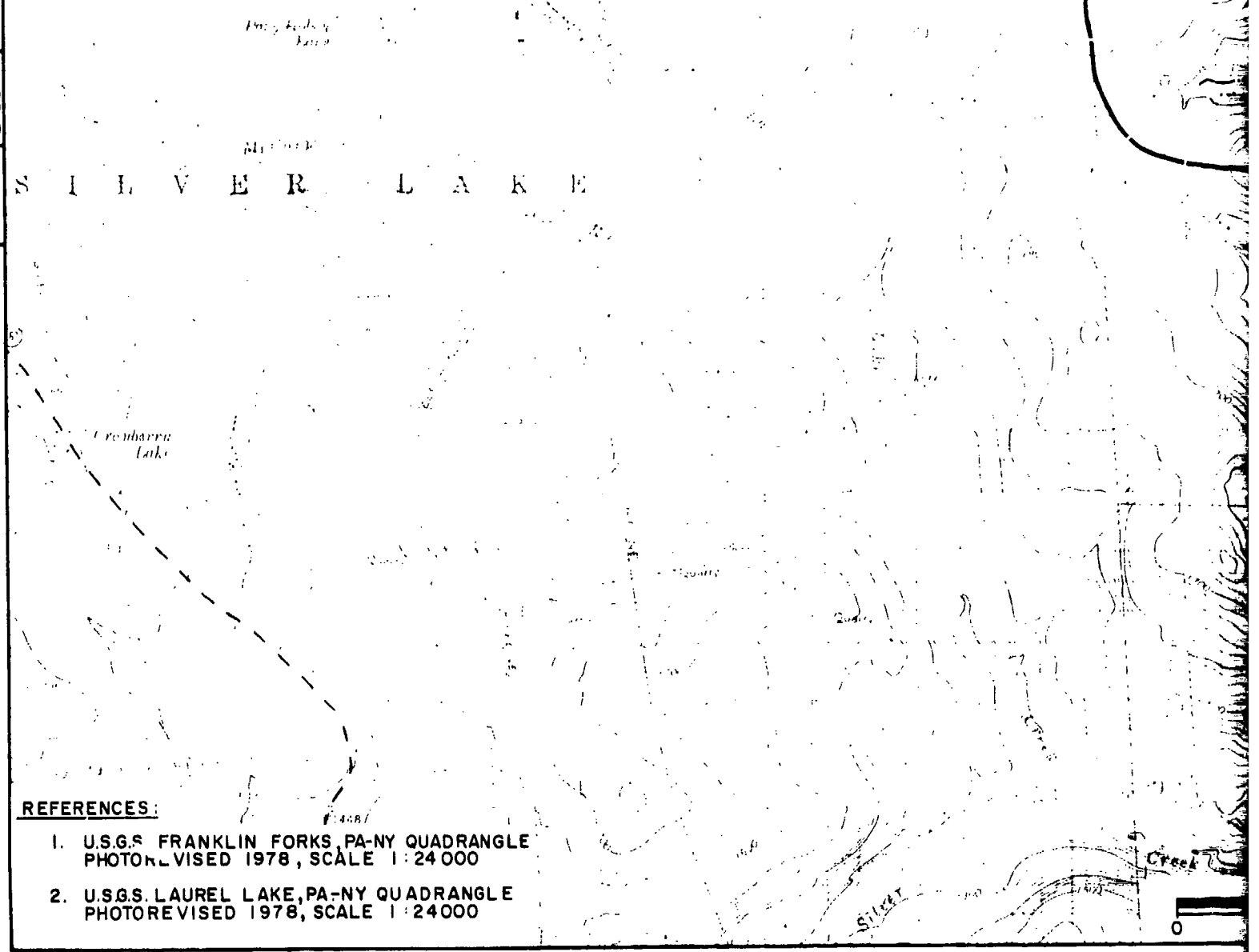
APPENDIX E

PLATES

DRAWN BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE	DRAWING NUMBER
ACS	12-22-80				2/10/81	80-556-B39



KEY PLAN



REFERENCES:

1. U.S.G.S. FRANKLIN FORKS, PA-NY QUADRANGLE PHOTOREVISED 1978, SCALE 1:24000
2. U.S.G.S. LAUREL LAKE, PA-NY QUADRANGLE PHOTOREVISED 1978, SCALE 1:24000

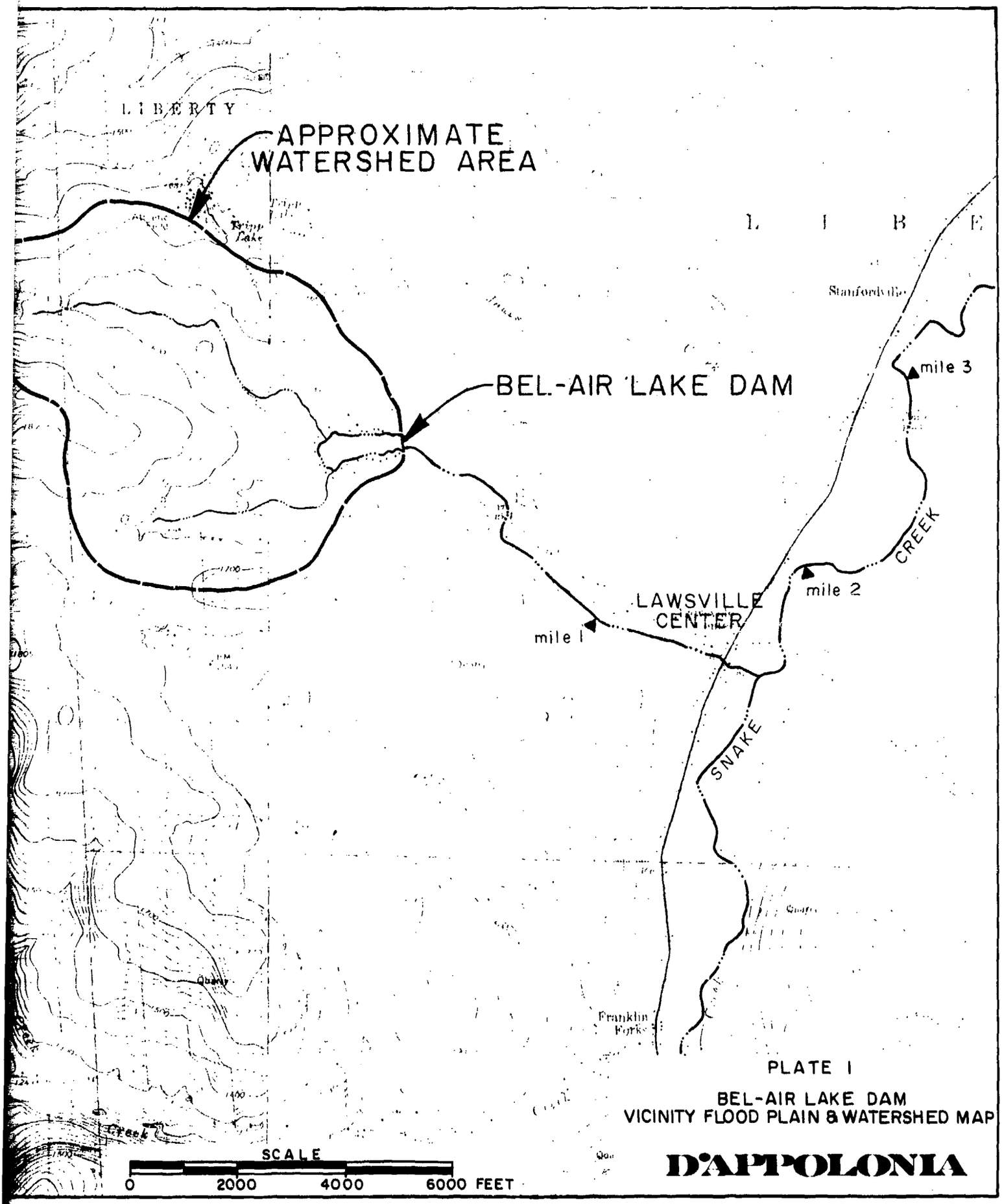


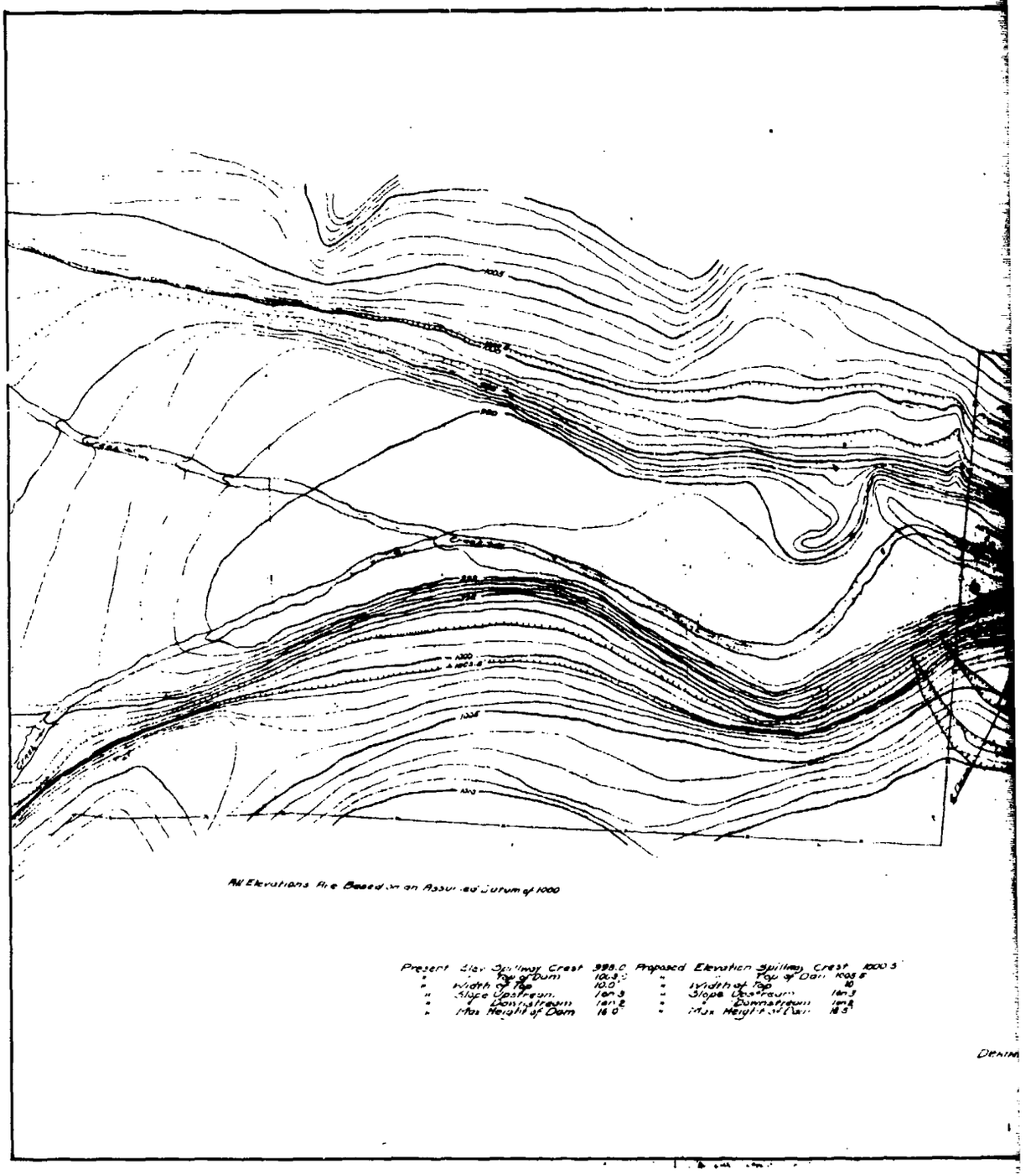
PLATE 1

BEL-AIR LAKE DAM
VICINITY FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

DRAWN BY	ACS 7.22.81
CHECKED BY	JHF
APPROVED BY	

DRAWING NUMBER 80-556-B40



All Elevations Are Based on an Assumed Datum of 1000

Present Elev. Spillway Crest	998.0		Proposed Elevation Spillway Crest	1000.5	
" Top of Dam	1008.3		" Top of Dam	1008.8	
" Width of Top	10.0'		" Width of Top	10	
" Slope Upstream	1on 3		" Slope Upstream	1on 3	
" " Downstream	1on 2		" " Downstream	1on 2	
" Max Height of Dam	16.0		" Max Height of Dam	16.5	

DRAIN

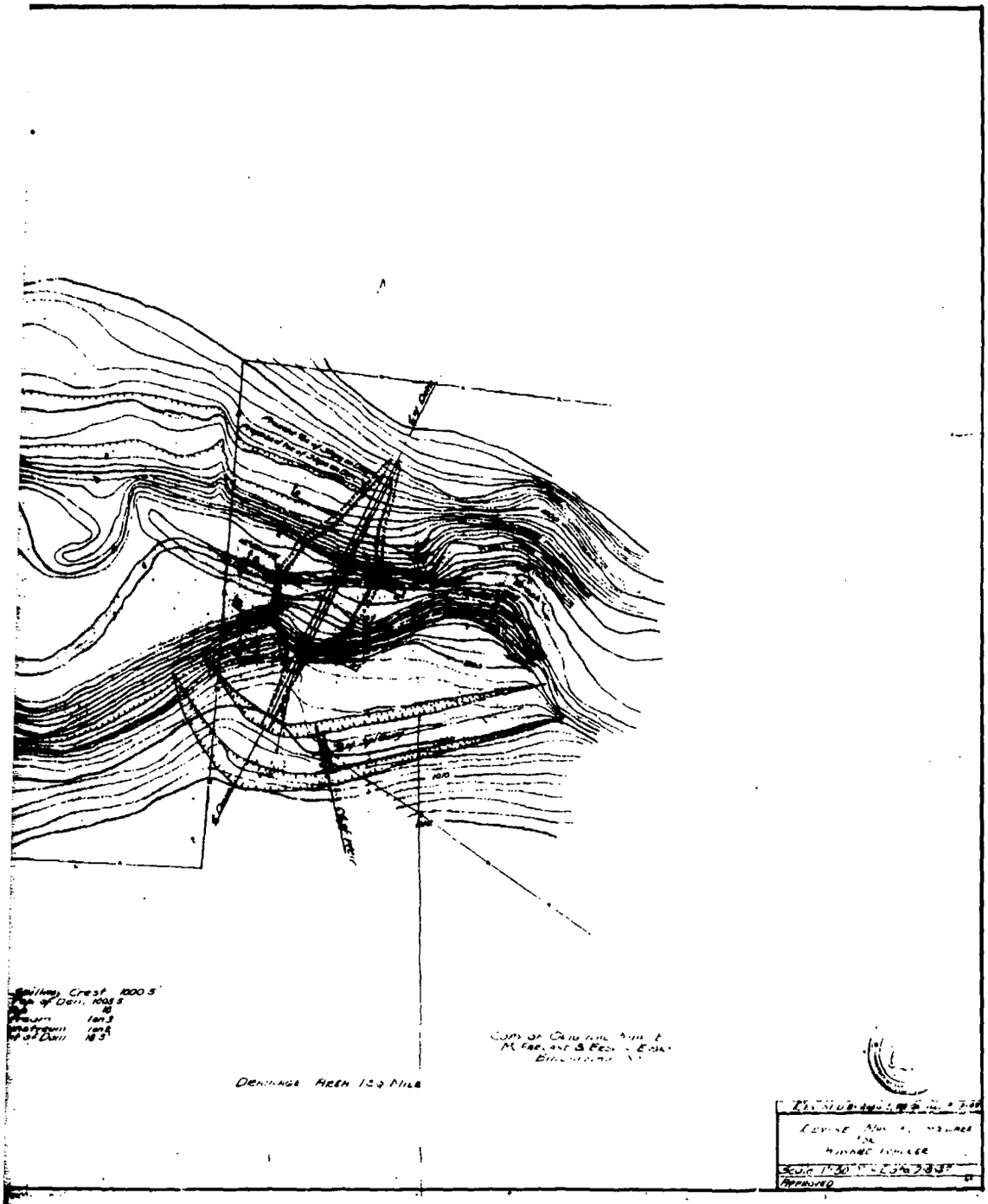
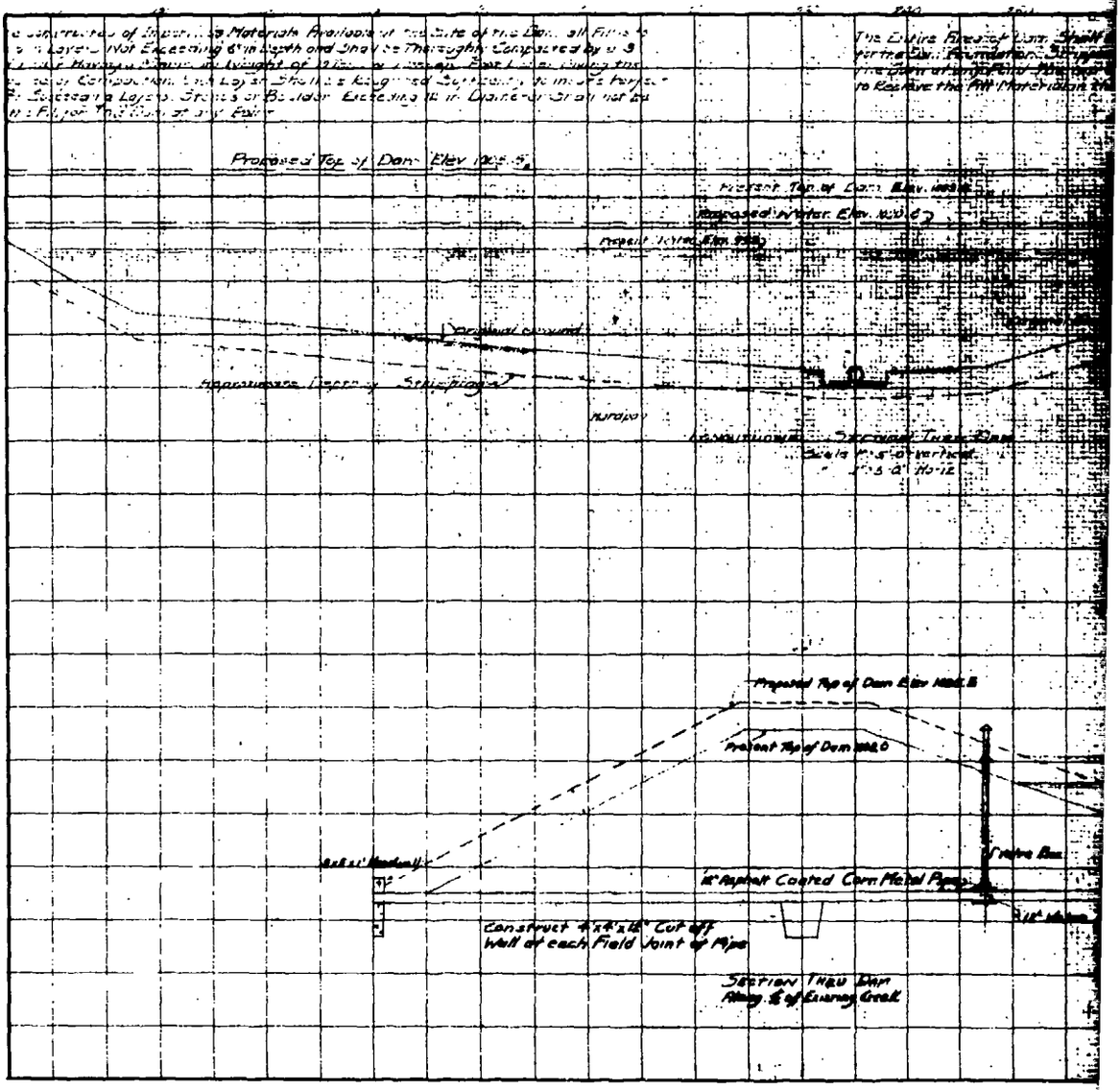


PLATE 2

DRAWN BY	ACS	CHECKED BY	TJE	8/10/81
	7-27-81	APPROVED BY	JBD	8/10/81

DRAWING NUMBER 80-556-B41



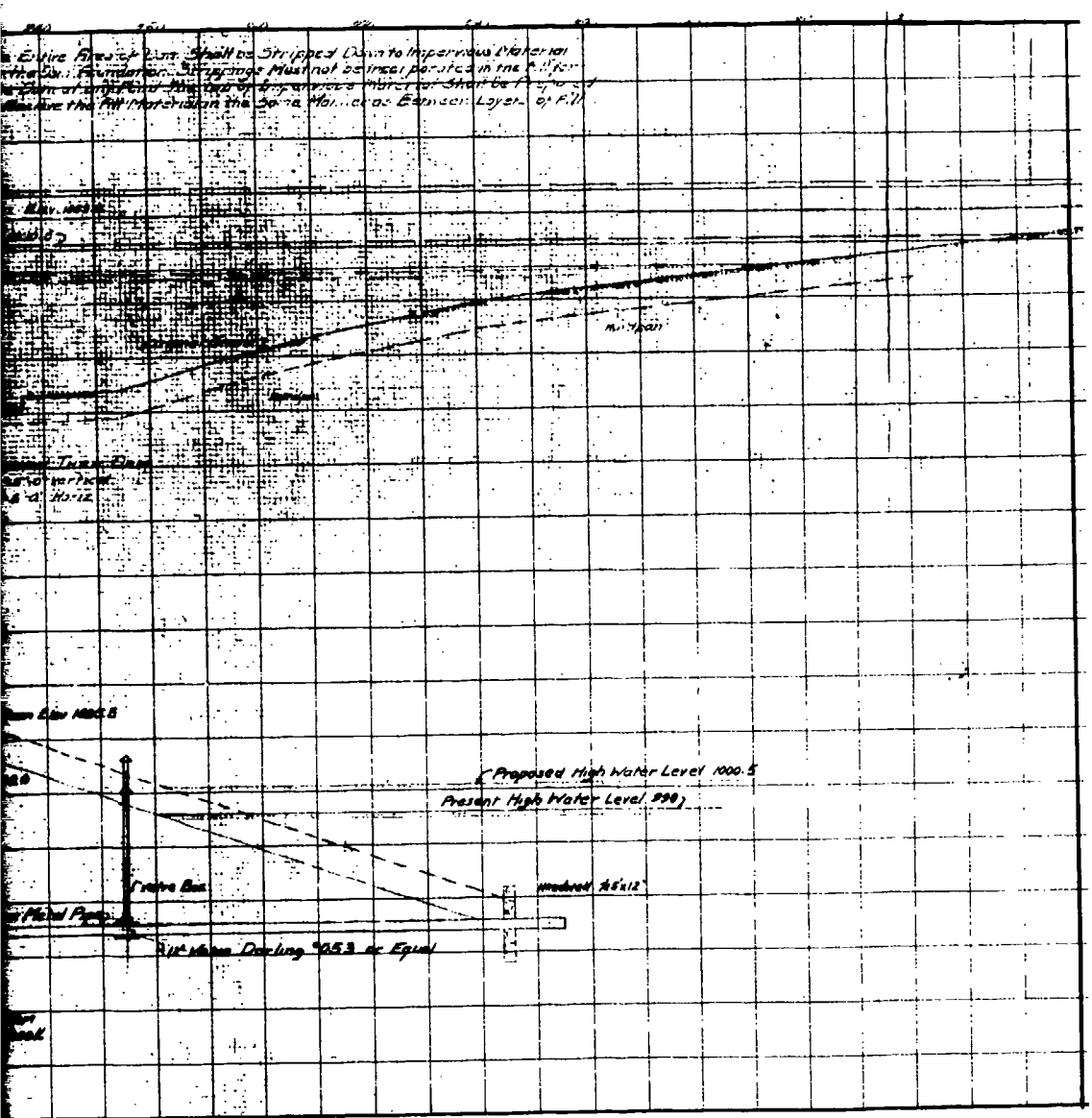
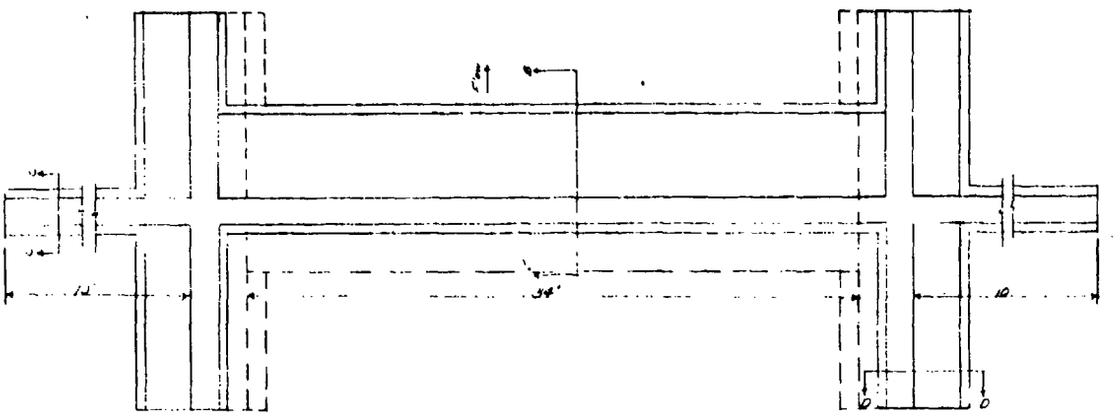


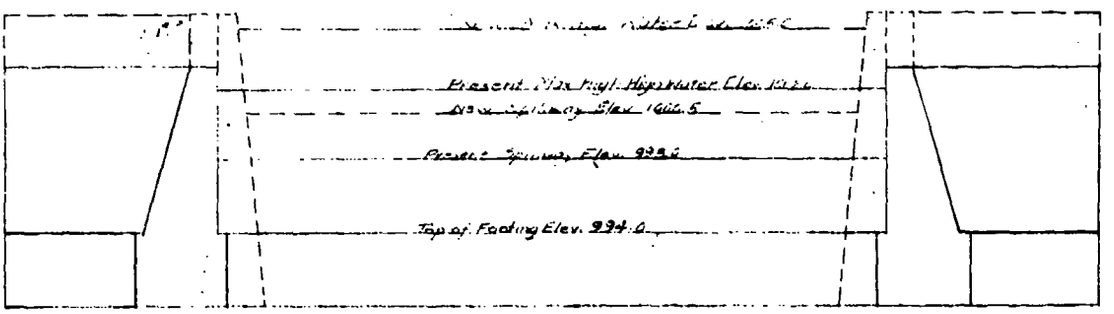
PLATE 3

D'APPOLONIA

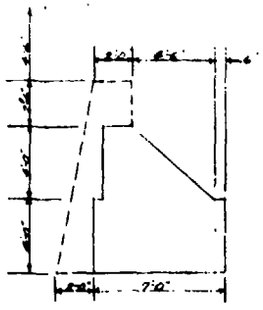
DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
AGS 7-22-81	HE	JHP	80-556-842



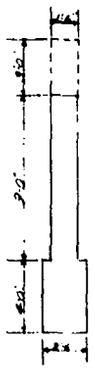
PLAN OF SPILLWAY



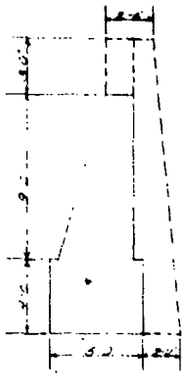
ELEVATION OF SPILLWAY



SECTION "BB"



SECTION C C



SECTION D D

Note
Present Conc. Walls to be Roughened up & Coated With Conc Grout, Dowels to be Placed in Present Walls to Hold Additional Conc.

——— Present Face Line of Spillway Walls
- - - - - New " " " " "

HOWARD WALKER DAM
ADDITONAL SPILLWAY DETAILS
Scale 1/4" = 1'0"

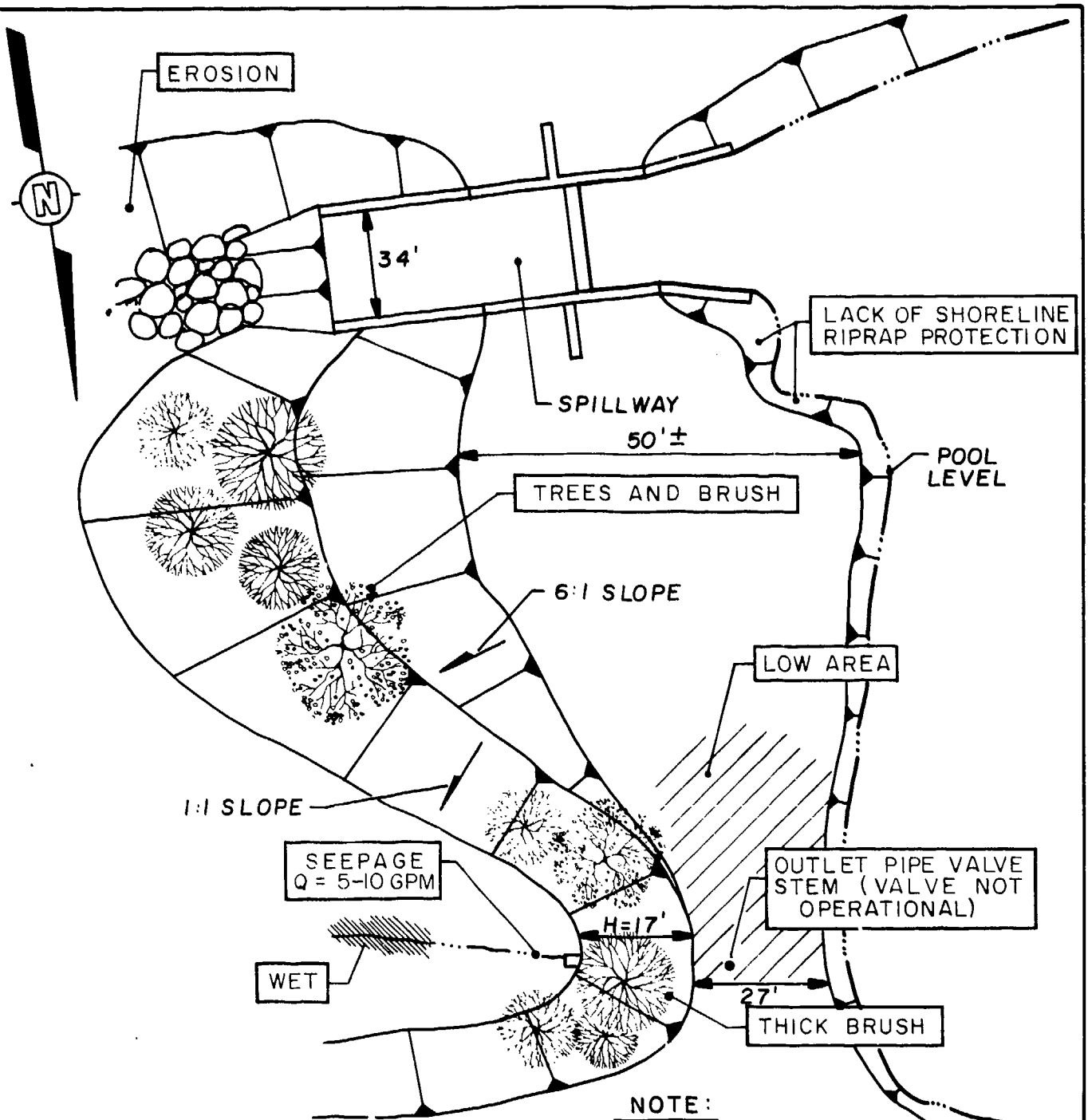
COPY OF ORIGINAL MAP BY
McFARLAND & BROWN ENGRS
BINGHAMTON N.Y.

Revised 9-19-49 By [illegible]

PLATE 4

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY		8-10-81	DRAWING NUMBER 80-556-A35
	2-27-81	APPROVED BY		3/11/81	



NOTE:

POOL LEVEL AT DATE OF INSPECTION: AT SPILLWAY CREST.

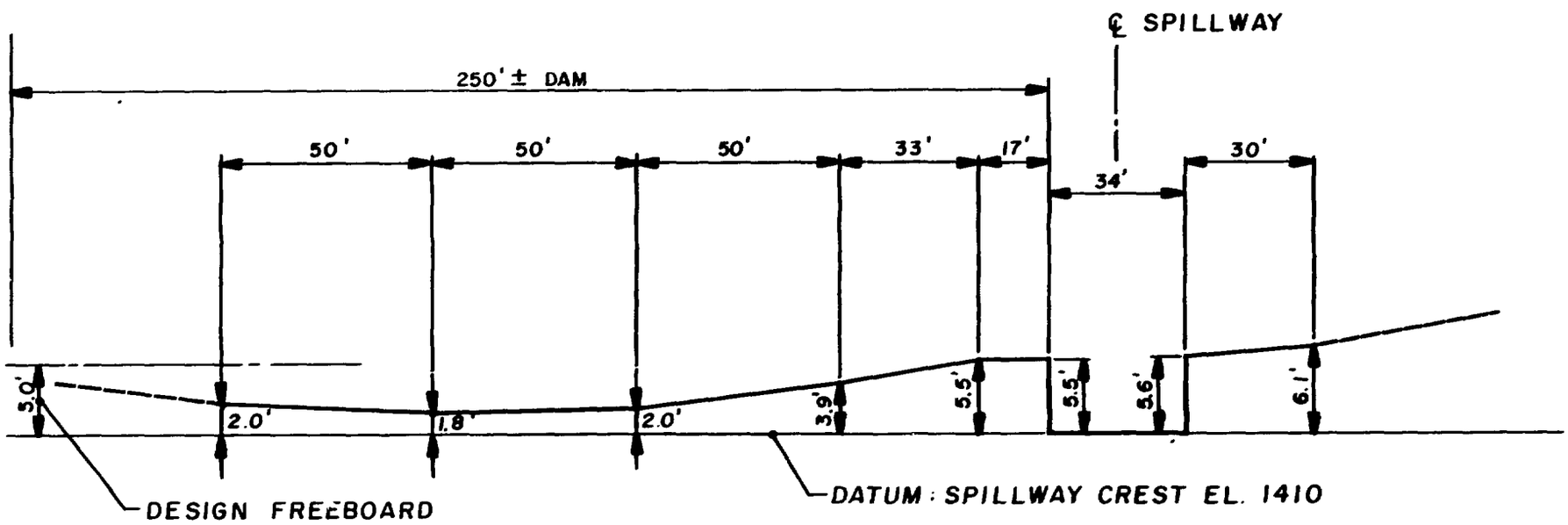
PLATE 5

BEL-AIR LAKE DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: MAR. 24, 1981

D'APPOLONIA

NOT TO SCALE

DRAWN BY	ACS 7-27-81	CHECKED BY / APPROVED BY	BE / [illegible]	8-10-81 / 8/10/81	DRAWING NUMBER 80-556-A36



DAM CREST PROFILE
(LOOKING DOWNSTREAM)

NOTES :

1. DAM CREST WAS SURVEYED RELATIVE TO SPILLWAY CREST LEVEL.
2. DATUM ELEVATION WAS INTERPOLATED FROM U.S.G.S. MAP, THEREFORE IS APPROXIMATE

PLATE 6

BEL-AIR LAKE DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: MAR. 24, 1981

DAPPOLONIA

APPENDIX F

REGIONAL GEOLOGY

REGIONAL GEOLOGY
BEL-AIR LAKE DAM

The Bel-Air Lake Dam is located in the glaciated low plateaus section of the Appalachian Plateau physiographic province, characterized as a mature glaciated plateau of moderate relief.

The geologic structure consists of a series of northeast trending folds (approximately N70°E) which plunge gently to the southwest. The dip of the limbs of the folds in the vicinity of Bel-Air Lake Dam is less than two degrees, with the southeast limb slightly steeper than the northwest limb. The dam is located just north of the Rome Anticline. In general, the discontinuity trends are northeast and northwest.

The stratigraphy consists of glacial till which will range in thickness from a few feet to approximately 200 feet. The glacial till is underlain by the Devonian Catskill Formation, which is approximately 1,800 feet thick in this area. The Catskill Formation is continental in origin, consisting of red shale and cross-bedded red and green sandstone and siltstone. The shale strata tend to weather rapidly when exposed.

DRAWING NUMBER 80-556-A2

DRAWN BY	ACS 1-2-81
CHECKED BY	JHP 2-17-81
APPROVED BY	

GEOLOGY MAP

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA, DEPARTMENT OF ENVIRONMENTAL RESOURCES, DATED: 1980
SCALE 1:250,000

D'APPOLONIA

DRAWN BY	DATE	CHECKED BY	DATE	DRAWING NUMBER
ACS	1-2-81	APPROVED BY	2-17-81	80-556-A4

PENNSYLVANIAN

APPALACHIAN PLATEAU

Allegheny Group
Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Pottsville Group
Predominantly sandstones and conglomerates with thin shales and coals; some coals minable locally.

ANTHRACITE REGION

Ppd

Post-Pottsville Formations
Brown or gray sandstones and shales with some conglomerate and numerous minable coals.

Pottsville Group
Light gray to white, coarse grained sandstones and conglomerates with some minable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mauch Chunk Formation
Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Loyalhanna Limestone at the base in southwestern Pennsylvania.

Pocono Group
Predominantly gray, hard, massive, cross bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

Pc

Conemaugh Formation
Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

DEVONIAN

UPPER

CENTRAL AND EASTERN PENNSYLVANIA

Oswayo Formation
Brownish and greenish gray, fine and medium grained sandstones with some shales and scattered calcareous lenses; includes red shales which become more numerous eastward. Relation to type Oswayo not proved.

Dck

Catskill Formation
Chiefly red to brownish shales and sandstones; includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east

Dm

Marine beds
Gray to olive brown shales, graywackes, and sandstones; contains "Chemung" beds and "Portage" beds including Burket, Brallier, Harrell, and Trimmers Rock; Tully Limestone at base.

Ds

Susquehanna Group
Barbed line is "Chemung-Catskill" contact of Second Pennsylvania Survey County reports; barbs on "Chemung" side of line.

GEOLOGY MAP LEGEND

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA., DEPARTMENT OF ENVIRONMENTAL RESOURCES, DATED: 1960
SCALE 1:250,000

D'APPOLONIA

10 1283 HERCULENE. A&B SMITH CO., PGH., PA LT1230-1078